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ENGINEERING EXPERIMENT STATION
of the Georgia Institute of Technology
Atlanta, Georgia

STATUS REPORT NO. 31

PROJECT NO. 116-18

INVESTIGATION OF FUNDAMENTAL PROPERTIES OF ELEMENTS AND THEIR COMPOUNDS INCLUDING THE RARE EARTHS AT VERY LOW TEMPERATURES WITH PARTICULAR EMPHASIS UPON SUPERCONDUCTIVITY

By

W. T. ZIEGLER

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NAVY DEPARTMENT, OFFICE OF NAVAL RESEARCH
CONTRACT NO. N6-ori-192, TASK ORDER I
NR 016-406

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AUGUST 1, 1953 to NOVEMBER 1, 1953

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I. SUMMARY

Construction and some preliminary testing of an adiabatic shield-type calorimeter for specific heat measurements over the range 15° to 320° K. have been completed. Further work with the calorimeter awaits the completion of the calibration of several platinum resistance thermometers.

A cryostat for calibration of the above-mentioned platinum resistance thermometers has been completed and calibration of the thermometers against a standard thermometer calibrated by the National Bureau of Standards is in progress. Calibration of the thermometers in the range 273° to 323° K. is largely complete. Calibration over the range 12° to 273° K. is in progress.

II. LOW-TEMPERATURE RESEARCH

The immediate objective of this research is the determination of the heat capacities of several rare earth oxides (notably La_2O_3, Nd_2O_3 and Pr_2O_3) over the temperature range 15° to 320° K. This objective has involved the construction of an adiabatic calorimeter for the heat capacity measurements and a cryostat for calibrating the platinum resistance thermometers to be used against a standard thermometer calibrated at the National Bureau of Standards.

At the present time the calorimeter is essentially finished. Specific heat measurements await the completion of the calibration of a thermometer for use with the calorimeter.

The cryostat for calibrating the thermometers has been completed, and calibration of the thermometers has been started.

Detailed descriptions of the calorimeter, the cryostat and thermometers will be given in a later report.

A. The Adiabatic Calorimeter

The calorimeter is of the adiabatic-shield type and is designed to accommodate a calorimeter can having a capacity of approximately 100 cm^3. The adiabatic shield and its associated electrical controls are similar to those employed by Scott et al.[1] The electrical control circuits for the adiabatic shield have been used in the operation of the cryostat and found to operate satisfactorily.

B. The Cryostat

The cryostat for calibrating the thermometers consists of a cylindrical copper block (approx. 1076 gm.) having four holes in which the thermometers may be mounted. The copper block, B, is suspended within a vacuum jacket from a brass pot, P, which may be filled with liquid nitrogen or hydrogen as desired. The copper block is surrounded by an adiabatic shield, AS, which, in turn, is surrounded by a radiation shield attached to the bottom of P. The shield, AS, can be cooled by bringing it into mechanical contact with P by means of a windlass in a manner similar to that described by Ruehrwein and Huffman.[2] It can be heated by three electrical heaters wound on the outside surfaces of the top, side and bottom. By suitable control of the current in these heaters the temperature difference between AS and B (as shown by three-junction copper-constantan difference thermocouples) can be controlled to several thousandths of a degree in the range 0° to 50° C.

No tests of stability have been made, as yet, at temperatures below 0° C.; such tests will be made within the next few weeks.

C. Platinum Resistance Thermometers

Four strain-free platinum resistance thermometers of the four-lead coiled-helix type, wound on mica crosses, as described by Meyers,[3] have been construc-

ted. Three of these, Nos. 1, 2 and 3, were constructed, using pure gold to weld the platinum coils (B. and S. No. 38) to the platinum leads (B. and S. No. 32). In a fourth (No. 4) all platinum wires were fused together without the use of a second welding metal. These thermometers have room-temperature resistances varying from 31 to 35 ohms.

After annealing at 500° - 650° C. for several hours, the strain-free platinum coils, mounted on the mica cross, were enclosed in a copper case, the leads being brought out through commercially available metal-to-glass terminals (Electrical Industries, Inc., Type AA-40T-S). These terminals consist of small tubes (0.040-inch O.D.) sealed in a special glass of the Pyrex type. From the few experiments carried out so far, these terminals appear able to withstand temperatures as low as -195° C. without electrical or vacuum failure. The finished thermometers are 9.5 mm. in diameter and 80 mm. long. The upper end of the thermometer is enlarged to form a section 12.5 mm. long by 17.5 mm. in diameter in which the four sealed terminals are located. The thermometers were filled with helium gas at room temperature and sealed off under one atmosphere pressure.

Calibration of these thermometers is now in progress. This is being done by direct comparison with a platinum resistance thermometer of similar type, calibrated by the National Bureau of Standards over the range 10° K. to the sulfur point (444.6° C.). This thermometer is very similar in construction to those described by Hoge and Brickwedde.[4] So far only the temperature range 0°-50° C. has been covered. The measurements have not yet been analyzed critically, but the behavior of the thermometers appears satisfactory.

III. FUTURE WORK

Calibration of the platinum resistance thermometers to be used in the heat capacity measurements over the range 15°-320° K. will be continued.

It is hoped that preliminary specific heat measurements can be begun shortly with the adiabatic calorimeter. These measurements await the completion of the thermometer-calibration experiments.

IV. PERSONNEL

The following individuals have been associated with the project during the period covered by this report.

Name	Position	Full-time	Part-time
Dr. W. T. Ziegler	Director	August, September	October
Mr. H. A. McGee, Jr.	Research Assistant	August, September	
Mr. Zelvin Levine	Research Assistant	August, September	

In October the Project Director spent about one-half of his time on this project, although during the academic year it is expected that he will normally devote about one-fourth of his time to this work. (This is in accord with the arrangements made under the extension of the present contract.)

Mr. McGee has resumed his graduate fellowship in chemical engineering but is continuing to work part-time on the project (without compensation). He will assist with the calibration of the thermometers and the specific heat measurements. In return he will use the finished calorimeter to make specific heat measurements on several organic compounds as his Ph.D. thesis problem.

Mr. Levine has resumed his graduate studies and is not presently available to the project.

It is hoped that additional graduate students can be added to this group in the near future.

Respectfully submitted:

W. T. Ziegler

W. T. Ziegler
Project Director

Approved:

Herschel H. Cudd

Herschel H. Cudd, Director
Engineering Experiment Station

V. BIBLIOGRAPHY

(1) Scott, R. B., Meyers, C. H., Rands, R. D., Brickwedde, F. G., and Bekkedahl, N., J. Research Nat. Bur. Standards 35, 39 (1945).

(2) Ruehrwein, R. A., and Huffman, H. M., J. Am. Chem. Soc. 65, 1620 (1943).

(3) Meyers, C. H., Bur. Standards J. Research 9, 807 (1932).

(4) Hoge, H. J., and Brickwedde, F. G., J. Research Nat. Bur. Standards 22, 351 (1939).